

XIV. LIFE SAFETY

INTRODUCTION

The following section covers fire and life safety improvements. Based upon surveys conducted February 23 and March 29, 2000, the section includes an initial evaluation and approach for addressing fire and life safety concerns.

1. Building Description.

The existing State Capitol Building is a four-story building with a basement. Each floor occupies a footprint of approximately 70,000 square feet. A large rotunda area connects the upper floors. The second floor is the base of the rotunda with large open balconies on the third and fourth floors. The first floor is separated from the rotunda area by a floor slab but is environmentally open to the rotunda via six large stair openings. The floor-to-floor dimension is approximately 16 feet.

The building houses the Assembly and Senate Chambers, and the State Supreme Court. Each of these areas would be classified as an assembly (A-3 or A-2.1) occupancy. The building also houses other offices and storage areas related to the previously mentioned building uses or other State functions. Some first floor space and other areas of the building house historical exhibits similar to a museum. Also, the main rotunda area is intended to be unoccupied circulation space, but will undoubtedly be occupied by tour groups or other State sponsored assembly gatherings.

2. Applicable Codes and Standards.

This building is required to be maintained in accordance with the codes enforced at the time of construction. As renovations or modifications were conducted, those renovations or modifications should have followed the codes applicable at the time of renovation. As such, this building should conform to the requirements enforced for original building construction in 1912 and codes enforced for modifications at various times over the life of the building. Any modifications conducted as part of this building renovation should be conducted in accordance with the building codes enforced at the time of project permitting. Currently, the Utah State Building Code is based upon on the 1997 Edition of the Uniform Building Code. At the time this project is carried out, the building code could be based upon the 2000 Edition of the International Building Code. However, the adoption of the new building code is contingent upon hearings conducted over the next 12 to 18 months and may change. The final code to be enforced at the time of this project is still unclear.

Some of the major upgrades required for full compliance with the current Uniform Building Code for the current building configuration are as follows:

- a. Automatic sprinkler protection throughout the entire building.
- b. New fire alarm system to provide detection and notification throughout the building.
- c. Three (3) enclosed stairs to provide exiting from the fourth floor. If the occupant load on any one of the upper floors is determined to exceed 1000 persons, the number of enclosed exit stairs required to serve that floor would be increased to four (4).
- d. Smoke exhaust system for the rotunda area and all areas not separated from the rotunda area by 1-hour rated construction. An emergency generator would be required to provide secondary power to the smoke control system.
- e. Separation of the office space from the rotunda area on at least one of the four floors open to it. This may be accomplished by fully separating the first floor from the second floor using fire

resistive construction.

- f. Construction of a 1-hour fire-resistive rated corridor system for the basement.
- g. Protection of vertical shafts by 2-hour fire-resistive construction.

This list is not exhaustive. There may be additional items required to provide compliance with the current code.

If the renovation is carried out for this building, it may not necessarily mandate compliance with the current building code. The current building code may only be applied to those portions of the building being modified. Basic building design constraints such as construction type and dealing with interconnected floors will still be subject to the requirements of the original building project.

In addition to being an existing building that may not be subject to the retroactive application of current building codes, it is also a historic building. Building codes in use across the nation generally have affiliated requirements applied to existing historic buildings that identify a minimum level of safety required for modifications to. In this case, the historic building code that would be applied is the Uniform Code for Building Conservation (UCBC). This document is published by the International Conference of Building Officials and accompanies the 1997 Uniform Building Code. We anticipate that a historic building code associated with the 2000 International Building Code will be issued in a similar manner.

3. Performance-Based Design Approach.

Because this is a unique building with significant historic features that should be maintained and because the codes do not contemplate many of the large scale features we have developed an approach based upon the overall performance of the building and not on strict compliance with any specific code. As guidelines for the approach, we have used, to the extent possible, rules from the current Uniform Building Code (which will be modified to incorporate International Building Code requirements when those are better understood). To identify retroactive improvements to be made for general building systems, we have referenced the requirements in the Uniform Code for Building Conservation as well as approaches outlined in the National Fire Protection Association (NFPA) Standard 101, the Life Safety Code and NFPA 101M Alternative Approaches to Life Safety. Using the NFPA codes is appropriate because they have standards specifically created for existing buildings. These codes will be used as tools to develop an overall design approach that satisfies the goals and objectives determined early in the design.

The overall approach is based upon the general performance of building systems and the performance of the building relative to the general level of life safety rather than specific compliance to the current building code requirements. Because the proposed approach does not meet the letter of the code, it should be based on a rational analysis that considers the building performance in response to a design fire. This type of design approach is subjective and requires the approval of the authority having jurisdiction. It is generally required that such an approach be properly documented and that the resulting design be adequately justified.

The UBC provides a mechanism to develop alternates to what is prescribed by the code. This process is identified in Section 104.2.8 of the UBC under the heading of “Alternate materials, alternate design and methods of construction”. This section allows the building official the authority to approve alternates provided that such alternates are at least equivalent to that prescribed by the code. Often, this is accomplished by providing some other additional means of protection is provided to compensate for areas where the design does not meet prescriptive code requirements. Therefore, these types of alternates are still consid-

ered at least equivalent to the prescriptive requirements.

Prescriptive requirements are generally developed based on historical fire data and are often conservative to cover a wide range of circumstances. However, it is also possible that the prescriptive requirements may not provide the level of protection necessary for a specific situation. For example, the UBC requires that travel distance in a sprinklered building not exceed 250 feet. There are some buildings where a travel distance may exceed 250 feet while still providing an acceptable level of life safety. Conversely, buildings may also exist where the allowable travel distance of 250 feet presents a hazardous situation for occupants. The bottom line is that it is difficult to determine if the level of protection provided is suitable for the particular building without evaluating the performance of the building. Since it is not practical to physically test each building, the engineering community often relies on fire modeling, risk analysis, timed egress analyses, and similar tools to quantify the level of protection.

The process of evaluating building performance to decide upon building design features is known as a performance based design. This approach could be permitted in the UBC as an alternate, under Section 104.2.8, as explained above. Design manuals developed by different groups outline this process. One of these manuals is the *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*, published by the Society of Fire Protection Engineers (SFPE). It provides a logical framework (see Figure 1) for conducting performance designs and recognizes both deterministic and stochastic approaches to evaluating performance of various buildings.

A critical component of the performance-based design is the involvement of the stakeholders, or individuals with an interest in the building design. These people include, but may not be limited to, the architect, the engineer, the authority having jurisdiction, the building owner, the building insurer, and any other individual or group that has some stake in the design. Together, this group establishes the performance goals of the building. Ultimately, the building is designed to meet the goals or objectives established by the stakeholders under a number of design fire scenarios. The result is that the performance of the building is quantified using analytical methods. The level of life safety is suited to the needs of the particular building.

A performance-based design approach may not be appropriate for all buildings. For simple building configurations, such as box-type structures, or for some new buildings that provide more design flexibility, adherence to prescriptive codes may be less expensive and may provide a reasonable level of protection. However, for atypical building designs or existing buildings built to conform to older, different codes, performance based design offers some flexibility to incorporate design features that may not normally be prescribed or recognized. Also, buildings with large open volumes, such as atria, are typically good candidates because the large open area provides a reservoir for heat and smoke that is not contemplated by traditional codes. The Utah State Capitol Building is a good candidate for a performance based design approach because it is an existing building with atypical design features that are important to its overall appeal; it has a controlled, consistent and predictable occupancy; and it contains a large open volume at its central core.

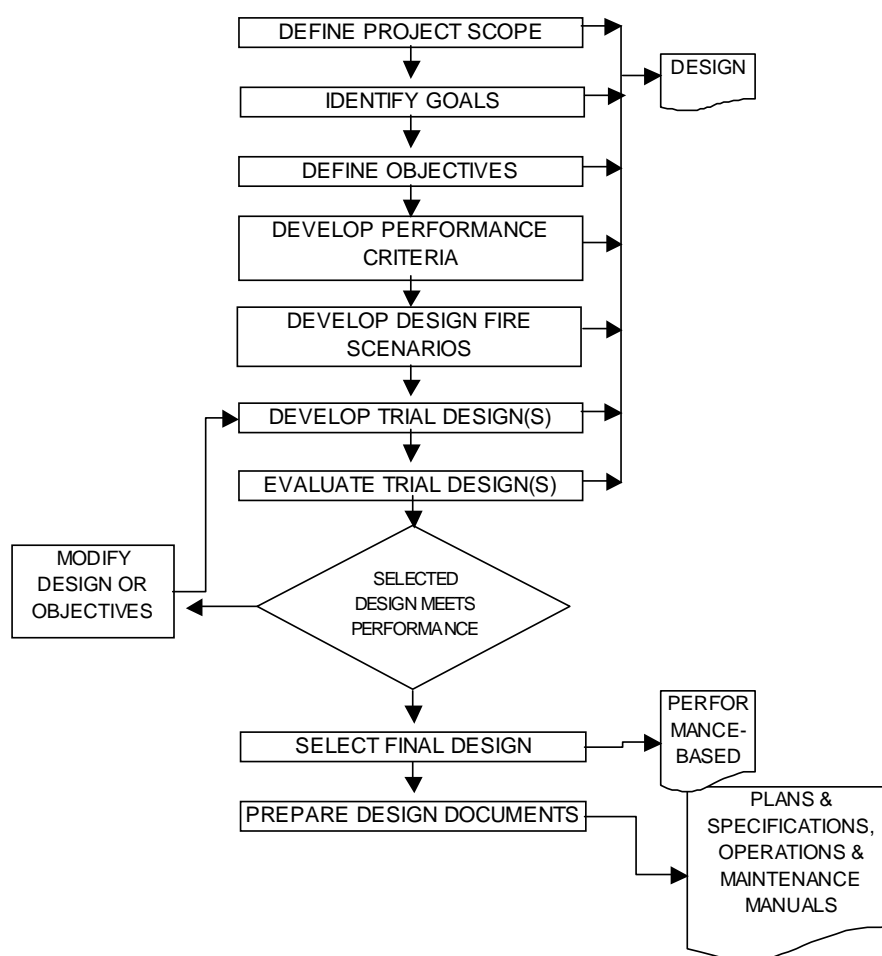


Figure 1: Performance-Based Design Flow Chart

The following approach is based on comparisons to various codes and on engineering judgement. Justification of these recommendations should be documented as part of a performance based approach as outlined above or verified to be equivalent to established codes.

We have divided the life safety approach for this building into seven general areas of life safety criteria. Those are construction type, occupancies, automatic sprinkler protection, fire alarm, floor separations, exiting, and elevator lobbies/emergency power. Each of those general categories is described below.

1. Construction Type

The building appears to have originally been built of non-combustible, fire resistive construction. The original design used the term “fireproof” to describe its construction. The size of the building is such that if it were constructed today, it would be required to be built of Type I or Type II fire resistive construction. Based upon this, we recommend that all future construction be built to Type I fire resistive construction standards. Further, any existing areas that have unprotected, non-combustible members should be upgraded to provide at least some fire-resistive protection of those members on a retroactive basis.

2. Occupancies

In general, the building can be classified as an A-2.1 occupancy building. Other occupancies should be separated as appropriate. Offices related specifically to the A-2.1 occupancies may be allowed in an unseparated fashion. Unrelated offices should be separated by 1-hour construction. Other more hazardous occupancies (such as storage areas) should be separated as required by the current building code. The basement will not house any public assembly occupancies and will therefore be considered a B (potentially A-3) occupancy area.

3. Automatic sprinkler protection

Because of other potential deficiencies in the building, the addition of an automatic sprinkler system will provide a great degree of flexibility and a significant increase in the level of life safety overall. Based upon previous discussions, we have assumed that a sprinkler system will be provided throughout.

In areas where the ceiling is located more than 50 to 55 feet above the floor level below, it may be possible to omit sprinkler protection based upon the questionable value of sprinklers in these areas. This may occur in the central rotunda area. If large Christmas trees or other fuel packages are anticipated for this space then the omission of sprinklers in the high ceiling areas should be re-evaluated.

The building is not currently provided with a standpipe system and none should be retroactively required. However, the building is large enough that one would be required for a new construction project and would be useful in a fire emergency. We recommend that installation of a Class III, wet, manual, standpipe system be considered with the sprinkler installation project.

4. Fire alarm

The existing building is provided with a wide variety of detection systems (smoke, heat and manual stations) in various areas. Because of the scale of the proposed modifications and the needed flexibility, we recommend a new fire alarm system. This system will monitor sprinkler systems in the building and will therefore effectively provide heat detection throughout the facility. Smoke detectors will be provided in specific locations where required for elevator recall or automatic closing assembly activation. We anticipate providing manual stations only where required for employee use and not for general public use. This item should be discussed with the facility users.

The system should be monitored on a 24-hour basis to initiate emergency response. An evacuation system should be provided via audible and visual means.

5. Floor separations

The building code allows two levels to be interconnected for this occupancy type. This building has openings between the first, second, third and fourth floors. In general, the basement is separated. That separation should be confirmed to be at least 2-hour fire resistive construction with 1-1/2-hour opening protection. It appears that this can be accommodated.

We recommend that the first floor also be separated from the upper floors. However, because of the large grand staircase openings between the floors, it does not appear to be architecturally feasible to create physical separations. However, the openings created are very similar to those allowed for escalators in the current building code for mercantile and other occupancies. We recommend an approach to separate the first floor, which follows the guidelines of the current building code and NFPA 13 for escalator separation. This would include a draft stop extending 18 inches below the ceiling around all such floor openings, and sprinklers spaced 6 feet apart adjacent to the draft stop. Following this approach (in addition to making the building fully sprinkler protected) the first floor should be considered separated from the second, third and fourth floors. The acceptability of this approach should be confirmed with reviewing officials. The alternative would be to create complete 2-hour separations at the floor openings.

Based upon the openness of the central rotunda area, it is not reasonable to separate all of Floors 2, 3, and 4. Rated floor separations (2-hour) should be maintained in all areas where floors are present. The central core area is a large open space characterized by very light fire loading. We understand that there will be temporary activities in this space that may increase fire loads, such as exhibits, or seasonal decorations. However, efforts should be made to limit combustibles in this area to very low quantities, or fire retardant materials. The open space is currently treated as a simple, three level interconnected space. Current building codes would mandate that this area be treated similarly to an atrium, or a modified mall. Because this is an existing building feature, retroactive correction is not required, but may be desirable.

Using the atrium approach would allow all three upper floors to be open to the central core area, but would require a smoke control system (which may be complicated and costly). Also, this approach would allow all exits to travel through the atrium, but would have to deal with excess travel distances (normally limited to 100 feet in an atrium and 250 overall from the fourth floor to an exit at grade).

Section 6-2.4.5 of the Life Safety Code has language that allows three interconnected levels, without classification of the space as an atrium. This section may be used as guidance for addressing this concern.

This approach would allow the three level space without a smoke control system, but would require the following:

1. The lowest, or next to lowest story within the communicating space is a street floor level.
2. The entire floor area of the communicating space is open and unobstructed.
3. The communicating space is separated from the remainder of the building by a smoke barrier.
4. The communicating space has ordinary hazard contents protected by an automatic sprinkler system.
5. Egress capacity of the communicating space is sufficient to provide for all the occupants of all levels within the communicating space to simultaneously egress the communicating space by considering it as a single floor area in determining the required egress capacity.
6. Each occupant within the communicating space has access to at least one exit without having to traverse another story within the communicating space.
7. Each occupant not in the communicating space has access to at least one exit without having to enter the communicating space.

This would require the installation of new stair shafts, or enclosing the existing exit stairs. However, some new exits are also recommended to provide additional exiting from the fourth floor and also to provide an enclosed stair for occupants of all upper floors. Item No. 7 may present the most difficulty, because it may entail constructing a corridor system to link the enclosed stairs to all portions of each upper floor. The approach to be followed should be discussed further.

6. Exiting

The current exit system, in most cases, provides an adequate number and capacity of exits. One exception to this is the fourth floor. This floor has an anticipated occupant load of approximately 900 people. This would require a minimum of three exits and a total stair width of nearly 23 feet. Currently there are only two exits from this floor, providing a total stair width of approximately 10 feet. Additional exit capacity should be provided for the fourth floor. This problem does not exist on the lower floors because of the grand staircases.

The major concern with the current exit arrangement is that all exits are in an open, unprotected environment in the building core. If this area were to become contaminated, all exiting from the third and fourth floors would be in jeopardy. In addition, exit travel distance exceeds the maximum permitted by code. To address these concerns, we recommend providing additional exits independent of the central core area. These exits should be in rated enclosures, should discharge to the building exterior, and should be accessible to all people in the office/chamber area, as well as the open core area. We recommend providing at least two new exits, each with approximately 78 inches of exit width each.

This goal has several significant difficulties. The two most significant are:

1. Where can the stairs be located?
2. How can access be provided to the stairs without having occupants enter the central core area?

An alternate, although less desirable approach, is to keep the same basic exit approach, and protect the core area with a smoke control system. This is less desirable because of the long term questionable reliability of mechanical smoke control systems, and because an open environment protected by smoke control is a less protected exit access than a rated enclosure.

The feasibility of providing new exits should be discussed with the project team.

The basement level includes a substantial corridor system. Concerns here include excess dead ends, storage areas open to the corridor, and minor violations of the rated partition. These deficiencies should be addressed to provide a rated 1-hour corridor system throughout the basement.

Exit drawings are included as an Appendix. These drawings are preliminary and show the basic occupant load breakdown for each floor and the location of smoke or fire-resistive barriers to separate the rotunda open space from the perimeter office/assembly areas. The occupant load factors used are those required by code for the type of use of each area.

7. Elevator lobbies/emergency power

The building is not provided with elevator vestibules. They would only be required where elevator landings open to rated corridors. We recommend providing rated elevator vestibules where elevators open to rated corridors. This may be done in any manner that provides a smoke resistive barrier.

The building is provided with emergency lights and exit signs on battery back-up power. Battery-powered systems can be a maintenance and reliability concern. We recommend considering an emergency generator in the project plan. If a smoke control system is provided, a generator will be required.

8. Summary

It may not be practical or possible to provide full compliance for the Utah State Capitol with current code and maintain the important architectural features of the historic building. An approach that clearly identifies reasonable life safety goals for the building design and provides an approach by which these goals can be met can provide a level of life safety that is equal to, if not greater than, what is intended by the code.

The recommendations provided in this report are preliminary and are based on engineering judgment. They are subject to a well-defined analysis that includes establishing goals, which can only be determined following discussion and consensus by all the stakeholders, including the authority having jurisdiction. We believe that this is an iterative process that can lead to a significant improvement in the level of life safety for this important historic building.